

**REMARKS**

Claims 1-7, 11-16 and 21 were pending in the application. In the Office Action dated March 10, 2010, claims 1-7, 11-16 and 21 are rejected. In the instant Amendment, claims 1-3 have been amended, and new claims 22 and 23 have been added. The amendments are proper in that they place the application in condition for allowance or in better form for appeal. Upon entry of the instant Amendment, claims 1-7, 11-16 and 21-23 will be pending in the application.

Claims 1-3 have been amended to recite Al in an amount of 0.005% or less. Support for the amendment is found in the specification at page 10, lines 9-13.

Support for new claim 22 is found in the specification at page 9, lines 9-20.

Support for new claim 23 is found in the specification at page 20, lines 30-36.

No new matter has been introduced by the present amendments. Entry of the foregoing amendment and consideration of the following remarks are respectfully requested.

**Claim rejections under 35 U.S.C. §112**

Claims 1-7, 11-16 and 21 are rejected under 35 U.S.C. §112, first paragraph, as failing to comply with the written description requirement since the amendment of the amount of N: 0.0031 to 0.031% in combination with Al content as high as 2.5% allegedly constitutes new matter. Independent claims 1-3 have been amended to recite Al 0.005% or less, thereby obviating the rejection to claims 1-3 and dependent claims 4-7, 11-16 and 21. Withdrawal of the rejection is respectfully requested.

**Claim Rejections under 35 U.S.C. §103(a)**

Claims 1- 7, 11-16 and 21 are rejected under 35 U.S.C. §103(a) as being unpatentable over Reason B of English translation of Japanese Office Action dated July 29, 2009 issued in corresponding Japanese Application No. 2005-514520.

The object of the present invention is to produce a high strength electrical steel sheet superior in magnetic properties such as magnetic flux density and core loss without greatly

changing the productivity such as cold rollability from that of conventional electrical steel sheet production process. Further, the inventive steel sheet is relatively soft until after the part making process when the part is hardened by the disclosed heat treatment resulting in a high strength and wear resistant processed part having excellent magnetic properties. The present invention provides the electrical steel sheet containing a fine Cu metal phase that provides high strength, high wear resistant electrical steel sheet without inviting a deterioration of magnetic properties or productivity that are accompanied by conventional high strength electrical steel sheet.

It is important that the specific metal phase characteristic of the present invention go through the following heat history for formation in the steel sheet after processing to an electrical part. This is to control the holding time in the 300°C to 720°C, preferably 300°C to 650°C, temperature range and the subsequent heat history in the process of producing the product sheet and heat treatment process after being processed to an electrical part. Passing through this process results in efficient formation of the metal phase characteristic in composition, size, and number density in a preferable process and enables hardening without affecting the magnetic properties much at all. According to the present invention, the steel can be increased in tensile strength by 30 MPa or more or in hardness by 10% or more by heat treatment for hardening. Specification at page 16, line 10 to page 18, line 9.

Regarding an average crystal grain size 30-300μm, the present invention explains that "the crystal grain size can be independently controlled from the strength by for example the maximum peak temperature of the recrystallization annealing and the holding time in this temperature range before heat treatment. Normally, it is controlled to 3μm to 300μm by heat treatment at 800°C to 1100°C or so for 20 seconds to 5 minutes or so." Specification at page 20, lines 30-36.

The Examiner has pointed to Reason B of English translation of Japanese Office Action which alleges that WO99/47718 ("WO'718") in view of JP10-183247 ("JP'247") would closely meet the present invention.

Reason B of the Japanese office Action states the following:

[WO'718] discloses that deterioration of magnetic properties can be restrained and increase strength if Cu is precipitated by

the nm order in a low carbon steel sheet. As a result, a person with ordinary skill in the art can easily achieve the present invention based on the teaching of the nm order Cu precipitation for increasing high strength for a non-oriented electrical steel sheet described in [JP'247].

English translation of Japanese Office Action at pages 2-3.

JP'247 discloses a steel sheet having  $C \leq 0.010\%$ , Si: 0.1-2.0%,  $Mn \leq 1.5\%$ ,  $Al \leq 1.0\%$ ,  $P \leq 0.15\%$ ,  $S \leq 0.01\%$ ,  $N \leq 0.01\%$ , and optionally containing one or more of  $Ni \leq 2.0\%$ ,  $Sn \leq 0.50\%$  and  $Cu \leq 1.0\%$ , and a balance of Fe and unavoidable impurities. The JP'247 steel sheet is subjected to hot rolling, one or two times cold rolling including intermediate annealing as it is without executing hot rolled sheet annealing or after hot rolled sheet annealing or self-annealing, is thereafter annealed, is subsequently subjected to skin pass rolling and is thereafter annealed. The skinpass rolling is executed under the conditions of 3-12% in the case the grain size before skinpass rolling is 20-50 $\mu m$ ,  $12\% \geq$  skinpass reduction rate  $\geq 0.04 \times$  grain size( $\mu m$ ) before skinpass rolling +1 in the case of the grain size of 50-200 $\mu m$ .

However, JP'247 does not disclose or suggest the non-oriented electrical steel sheet of the present invention having Si in the amounts as presently claimed, i.e., Si: 2.0 to 6.5% (claim 1) and Si: 3.1 to 6.5% (claim 21). The present specification teaches that:

[i]ncreasing the Si content degrades less magnetic properties and in particular it is possible to reduce the core loss and to increase the strength, so Si content is preferably in an amount of 1.0% or more, **more preferably 2.0% or more**, in the steel.

Specification at p. 8, l. 3 to p. 9, l. 3, emphasis added. See also p. 27, Table 3. In contrast JP'247 teaches that:

Si is an element effective in lowering iron loss as everyone knows, and in order to acquire this effect, it is necessary to make it contain 0.1% or more. On the other hand, since **magnetic flux density will fall, and degradation of rolling-operation nature and the rise of finishing annealing temperature will be caused and it will also become a high cost further if the content increases, it may be 2.0% or less.**

JP'247 at ¶ [0009], emphasis added. Furthermore, JP'247 only exemplifies Si in an amount of 0.17% (see, JP'247 Tables 1 and 2), an amount well below the presently claimed range.

Thus, JP'247 discourages the use of increased Si. There is no expectation that an increase of the amount of Si in JP'247 to the amount claimed would make it possible to reduce the core loss and to increase strength as achieved by the present invention.

Furthermore, JP'247 does not disclose or suggest the claimed metal phase comprised of Cu having a diameter of 0.1  $\mu\text{m}$  or less in the steel sheet by means of holding the steel sheet in a heat treatment at a temperature range of 300°C to 650°C for 5 seconds or more.

In this regard, the JP office action cites to WO'718 for allegedly teaching that "deterioration of magnetic properties can be restrained and increase strength if Cu is precipitated by the nm order in a low carbon steel sheet."

However, WO'718 relates to Cu high tensile steel used for an aperture grill of a color picture tube. WO'718 targets to obtain tensile strength of more than 60 kgf/mm<sup>2</sup> by means of precipitation of fine Cu phase ( $\epsilon$  phase) and using solid solution strengthening by P, and magnetic property:  $B_r$  (kG) /  $H_c$  (Oe)  $\geq 2.5$  by means of aging treatment. The steel sheet of WO'718 is a low C steel containing less than 0.01% of C, and less than 0.3% of Si, more concretely in examples shown in Table 1, the Si contents are 0.01 and 0.02%. WO'718 at page 4, lines 16-19 and 23-25. This kind of steel is a well-known Cu-HiTen steel, which is clearly distinguished from Si-containing non-oriented electrical steel sheet of the present invention.

As discussed above, the present inventive high strength non-oriented electrical steel sheet contains Si: 2.0-6.5% for use in a motor rotor. WO'718 requires low levels of Si and does not remedy the deficiencies of the JP'247 disclosure. In addition, a person skilled in the art would not have modified JP'247 with the steel WO'718 for an aperture grill of a color picture tube.

Furthermore WO'718 does not disclose a metal phase comprised of Cu having a diameter of 0.1  $\mu\text{m}$  less (preferably 0.001  $\mu\text{m}$  to 0.008  $\mu\text{m}$ ) obtained by means of holding the steel sheet in a heat treatment at a temperature range of 300°C to 650°C for 5 seconds or more. WO'718 does not disclose or suggest having the number density of 20 pieces/ $\mu\text{m}^3$  (claims 4 and 11) and an average crystal grain size of 30 to 300  $\mu\text{m}$  (claims 5, 13 and new claim 23) for increasing tensile strength by 30 MPa or more (claim 15) or in hardness by 10-fold or more (claim 14).

For at least the reasons discussed above, WO'718 does not remedy the deficiencies of JP'247 and a *prima facie* case of obviousness has not been established. Thus, JP'247 and WO'718, taken either alone or in combination, do not render the claimed invention obvious. Applicants respectfully request withdrawal of the rejection of claims 1-7, 11-16 and 21 under 35 U.S.C. §103(a) in view of Japanese Office Action dated July 29, 2009.

Claims 1 to 7, 11 to 16 and 21 are rejected under 35 U.S.C. §103(a) as being unpatentable over the machine translation of Japanese patent publication number 09-241793 ("JP'793") in view of Table 1.1. of Essential and Incidental Elements in Steel and Cast Iron.

It is the Examiner's opinion that:

JP-793 closely meets the claimed steel for the reasons stated in the previous office action dated October 2, 2009 but does not contain 0.003 to 0.0301 % N. Nevertheless, nitrogen is a conventional steel additive to increase strength properties as taught by NPL. Consequently, to add nitrogen in a range of 0.003 to 0.0301 % N would be a matter of routine optimization of an alloying constituent to achieve the desired degree of strength which is well within the skill of the artisan and productive of no new and unexpected results.

(Office Action at page 3).

However, JP'793 is not concerned with the magnetic properties of an electric steel sheet but instead is concerned with strength, ductility and toughness (JP'793, Abstract). The steels of JP'793 are for uses in "...structures, such as shells ... [of, for example] a car, and a marine vessel, and a building" (JP'793, paragraph [0002]). Applicants first respectfully submit that a person skilled in the art would not have optimized or otherwise modified such steels to make them non-oriented electric steels, since such modification would have rendered the steels unsuitable for the purpose of JP'793.

JP'793 discloses an Fe-Cu alloy steel having an optimized balance between strength and ductility and also between strength and toughness by controlling the Cu precipitates in the steel to be crystallized in the bcc-Cu form. Specifically, JP'793 teaches a reheating or end rolling temperature of greater than 750 °C, followed by a cooling rate of at least 10 °C/sec followed by an aging treatment from 10 to 120 min at 480°C to 600 °C in order to

nucleate and grow the bcc-Cu precipitates. JP'793 teaches "degradation of ductility by [increasing tensile strength] ... by conventional strengthening" (see, ¶ [0008]). Regarding conventional strengthening, JP'793 further teaches that:

[c]onventionally, as a means to [increase tensile strength] roughly divide a steel plate, and add solid-solution-strengthening elements, such as (1) Si, nickel, and Mo, so much, or add precipitation-strengthening elements, such as Nb, Ti, and V.

...

Although strengthening by the method of (1) mentioned above is used [the organization] regardless of a ferrite, bainite, and martensite for many years, if it is generally going to obtain high tensile strength, ductility and toughness will get worse in inverse proportion to it.

JP'793 at ¶¶ [0002] and [0003]. Thus, conventional strengthening causes ductility and toughness to degrade as the strength of the improves.

Table 1.1. of Essential and Incidental Elements in Steel and Cast Iron provided by the Examiner states that nitrogen is "added to some microalloyed steels to increase the amount of nitrides required for strengthening or grain size control (e.g., in a vanadium steel)."

However, JP'793 clearly cautions that "ductility and toughness will get worse in inverse proportion" to the improvement to tensile strength by precipitation-strengthening. Thus, it is not likely that a person of ordinary skill in the art would modify the JP'793 steel adding N for nitride strengthening, as suggested by the Examiner. There is no motivation to add N to the JP'793 steel and expect to improve the balance of strength and ductility or strength and toughness as is the object of the JP'793 technology.

Furthermore, the general disclosure of N addition to microalloyed steels in Table 1.1 alone encompasses a very large number of steels, most of which, based on the teachings of the present application, are not expected to provide the excellent magnetic properties required for high strength non-oriented electrical steel sheet. Specifically, the present application states that "[n]itrogen, like C, degrades the magnetic properties, and thus the amount is 0.0400% or less." Specification at page 11, lines 10-11. Furthermore, the present application states that:

[a]lmost all elements utilized in the past for increasing the strength in high strength electrical steel sheet not only are problematic in terms of the cost of addition, but also **have some detrimental effect on the magnetic properties**, so, in the present invention, they do not really have to be added for the purpose of increasing the strength.

Specification, at page 11, line 33 – page 12, line 2, emphasis added. Thus, the claimed balance of N in the present invention would not be obvious to a person of ordinary skill in the art in view of the general knowledge that precipitation strengthening interferes with the magnetic properties of electric steel.

Further, JP'793 does not disclose or suggest the present inventive production process of high strength non-oriented electrical steel sheet carried out by the steps of a recrystallization annealing heat treatment at 800°C to 1100°C or so for 20 seconds to 5 minutes or so in order to provide an average crystal grain size of 30-300 (claims 5, 13 and new claim 23), followed by the step of holding the steel sheet at 300-720°C for an appropriate time, and then controlling the heat history for obtaining a metal phase comprised of Cu having a diameter of 0.1µm or less.

For at least the reasons presented above, one of ordinary skill in the art according to the disclosure of JP '039 would not have arrived at the claimed high strength non-oriented electrical steel sheet of the present invention. Accordingly, the rejection of claims 1-7 and 11-16 under 35 U.S.C. §103(a) as obvious over JP '039 cannot stand, and should be withdrawn.

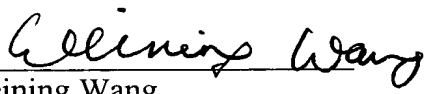
Application No. 10/574,553  
Reply to Office Action of March 10, 2010

In view of the foregoing amendments and remarks, Applicants respectfully submit that the present application is in condition for allowance. Early and favorable action by the Examiner is earnestly solicited. If the Examiner believes that issues may be resolved by a telephone interview, the Examiner is invited to telephone the undersigned at the number below.

Respectfully Submitted,

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